

Good Manufacturing Practice Guidelines

Coastal Characterisation & the CSO Text Alert Initiative

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Summary

UK coastal waters provide ideal environments for the natural growth and cultivation of bivalve molluscs. These environments are dynamic, being influenced by tidal and wind-driven currents. As growing pressure is placed on coastal regions for human settlement, there will be an increased need to exploit them as both a source of food production and discharge points for human faecal waste.

Water companies are responsible for the quality of their discharges, as determined by the Environment Agency. There are a number of different sewage treatment options that produce varying qualities of discharge (including primary, secondary and tertiary treatment). However, in some instances, untreated, diluted sewage waste water is legally released into the environment.

Combined Sewer Overflows (CSOs) function as a release valve during storm events. High rainfall can overwhelm sewage systems and begin to back-up towards their source. As these systems combine surface waters with sewage destined for treatment, a high volume of dilute sewage waste water is produced. Without this mechanism, dilute waste water would overflow into homes and offices or run through the streets. This protects human health and property from damage. CSO spills enter the environment without treatment, elevating faecal associated bacterial (*E.coli*) and viral (Norovirus) loads.

These periods of elevated contamination risk can cause serious food safety issues for bivalve mollusc harvesters. As these animals can retain bacteria and viruses from days to weeks (increased duration for viral loads in winter conditions), an unsafe product could be placed on the market if these spill events are not understood and mitigated against. The direction of the effluent plumes, produced by these spills, is affected by the character of the coastline. Understanding how local conditions influence the movements of these plumes is an essential first step in making informed active management decisions during CSO spill events.

This document indicates the information that local harvesters may use in order to make an informed active management decision. It also introduces a new Seafish initiative to provide real-time information on CSO spills to registered users (including how to register for the service). The information provided in this document should be used to assist current knowledge on the subject and provide guidance on how to make the most of the CSO text alerts.

CSO's are only one of a number of potential sources of contamination to coastal water bodies. Shellfish waters may also be impacted by continuous discharges from Sewage Treatment Works (STWs) and the downstream effects of urban and agricultural waste water run-off. It is important that CSO spills are understood as a part of the wider context of shellfish water contamination.

Contents

Summary	1
Glossary	3
Background	4
Combined Sewer Overflows (CSOs)	5
Characterisation	6
Effects on water movement	7
Tides & Dilution.....	7
Geophysical Parameters	8
Meteorological Conditions.....	9
Seasonality & Flushing Time	10
Classification	11
Contamination	12
E.coli	12
Norovirus.....	12
Waste Water Treatment:	13
Primary Treatment.....	13
Activated Sludge Treatment (AST)	13
Biological Filter (BF).....	13
Secondary Treatment.....	14
Rotating Biological Contactor (RBC).....	14
Biological Aerated Filter (BAF)	14
Submerged Aerated Filter (SAF).....	15
Tertiary Treatment.....	15
Membrane Bioreactor (MBR).....	15
Sending a CSO Text Alert	16
Attributes and Benefits of the Text Alerts	17
Active Management	17
Operating Decisions	17
Profile of a Spill	18
Spill Accumulation	19
How to Register	21
Bibliography	24
Acknowledgments	24

Glossary

- o **Active Management** – The continuous decision making process carried out in real time taking account of all the available information. The harvester is the best person to decide what action to take as regards when and where to harvest or not.
- o **Biochemical/Chemical Oxygen Demand (B.O.D/C.O.D)** is the amount of dissolved oxygen in a body of water needed to break down organic material and oxidise inorganic chemicals present.
- o **Bivalve Molluscs** are a class of shellfish, identified by their hinged shell – examples include oysters, mussels, clams, cockles and scallops.
- o **Coastal Character** – the local conditions of the coastline define its character. This includes the tidal and weather conditions, fresh water inputs and also the actual physical structure (depths) of the water body.
- o **Combined Sewer Overflows (CSOs)** are release valves for the waste waters that are received by combined sewer systems (both urban and industrial waste water, and street drainage). CSOs spill once the capacity of the sewage system is exceeded and the waters begin to back-up.
- o **Contaminants** – in the context of this document, it is any faecal associated bacteria/virus that can be accumulated by bivalve molluscs and affect product safety (e.g. *E.coli* & Norovirus).
- o **Cultivation** is the farming of a product. Within this context, cultivation refers to the active farming of bivalve molluscs. This differs from fishing wild populations because of the addition of control, either through enhanced repopulation or determining the growth area (e.g. using trestles).
- o **Ebb(ing) Tide** – out-going tide
- o **Effluent/Discharge** – this is what is actually released by the spill. In this context, the sewage waste water produced either during standard STW operation or CSO spills can be referred to as an effluent or discharge.
- o **Flood(ing) Tide** – in-coming tide
- o **Flushing Time** – the time taken for the entire of the water in a water body to be replaced.
- o **Land Run-Off** is normally caused by heavy rainfall. Flooding on fields and farmland is washed directly into nearby water courses rather than entering street drainage systems.
- o **Neap Tide** – highest low tide, lowest high tide
- o **Plume** – the ‘cloud’ of underwater pollution following a spill (i.e. the path of the contaminants).
- o **Receiving Waters** are the water bodies that directly receive the spill. In the case of CSO spills this could be small creeks and beckes that lead to more open shellfish harvesting waters.
- o **Sewage System** – sewage pipes and pre-treatment works, located before sewage treatment works.
- o **Sewage Treatment Works (STWs)** are owned by Water Companies and receive waste waters from nearby urban and industrial pipelines. Regular discharges are usually treated to a secondary standard. ‘Sensitive’ regions however, such as shellfish waters, can receive much cleaner, tertiary treated discharges.
- o **Spring Tide** – lowest low tide, highest high tide

Background

- o Bivalve molluscs (oysters, mussels, clams, cockles and scallops) are a healthy, nutritious food, high in protein and low in fat. UK coastal environments offer ideal conditions upon which wild and cultured beds of bivalve molluscs can grow. Local harvesters have a right to harvest from these beds, an operation that is often pivotal in sustaining the economy of fragile coastal fringe communities.
- o Equally, water companies have the right to discharge human sewage waste waters back into the environment. Under a government granted license, water companies are advised on the quality of waste water that they are allowed to discharge. This incorporates the legal discharge of untreated, highly dilute waste water from Combined Sewer Overflows (CSOs), which are used during storm events when the storage capacity of the sewage system is overwhelmed. Without CSOs, untreated sewage waste would back up into our homes and offices, or overflow into the streets.
- o Treated (reduced contaminant levels) and untreated sewage discharges enter water bodies which directly feed into coastal bivalve mollusc production areas, increasing contamination risk. To eliminate human illness, harvesters are legally required, through food legislation, to ensure that only a safe food is placed on the market. In this regard, harvesters are considered to be food business operators (FBOs).
- o Sewage contamination from relatively diluted discharges is an issue because bivalve molluscs filter feed. Contaminants, such as *E.coli* and Norovirus, are therefore retained within the gut of the animal where they can accumulate to potentially harmful levels (at much higher concentrations than the surrounding water). Consumption of these has been linked with the outbreak of gastroenteritis, symptoms of which, although unpleasant, usually subside within 48 hours.
- o To reduce the illness outbreaks related to the consumption of bivalve shellfish, harvesters regularly make management decisions, including end product testing. This is assisted by classification of each harvesting production area by the Food Standards Agency (FSA). This describes the base quality of the shellfish that are produced and defines the additional requirements to ensure that all food products are safe for market [see section 'classification' for more information].
- o In some circumstances, the provision of an alert to the activation of a CSO will provide enhanced information, allowing a harvester to make more effective active management decisions. Unfortunately, where harvesting takes place in the vicinity of continuous discharges of treated sewage, it is unlikely that text alerts will have an enhanced value.

-Health Warning-

The provision of information on CSO spills IS NOT a substitute for appropriate risk assessment and/or adequate microbial and viral sampling.

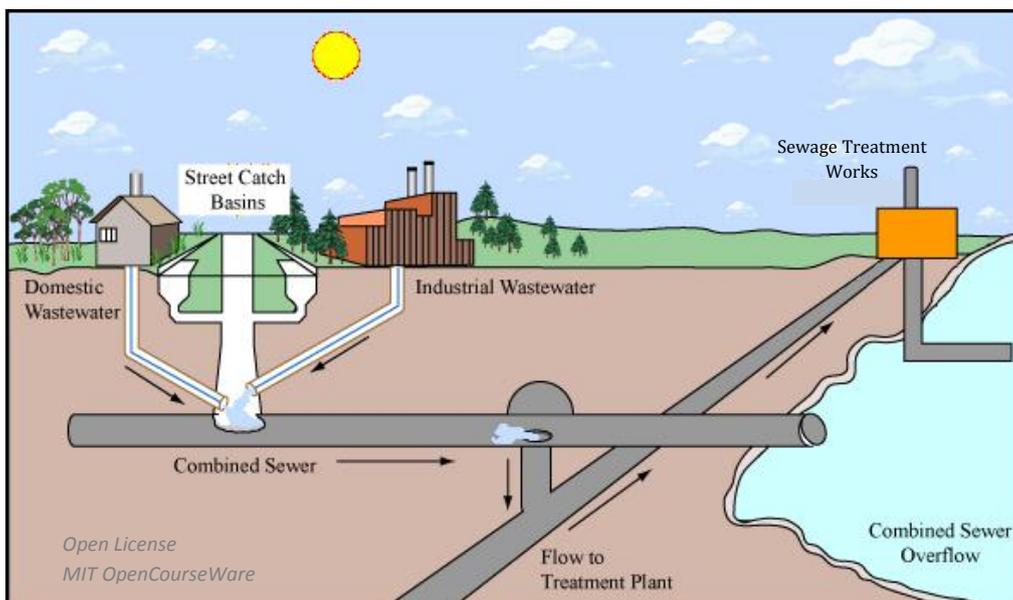
These guidance pages are intended to provide detailed information on the current threats to bivalve mollusc harvesting operations, in relation to coastal waste water discharges. They describe a Seafish initiative, designed and developed in partnership with water companies, which provides users with up-to-date information on CSO spills, including how to register to receive alerts and how to interpret the information. This guidance is intended to identify the need for enhanced risk assessments and active management to counteract the effects of such spills and offer a direction of how to proceed with this. A successful introduction of the CSO text alerts initiative will hopefully reduce the incidences of shellfish associated gastroenteritis resulting from the release of untreated sewage waste waters.

Combined Sewer Overflows (CSOs)

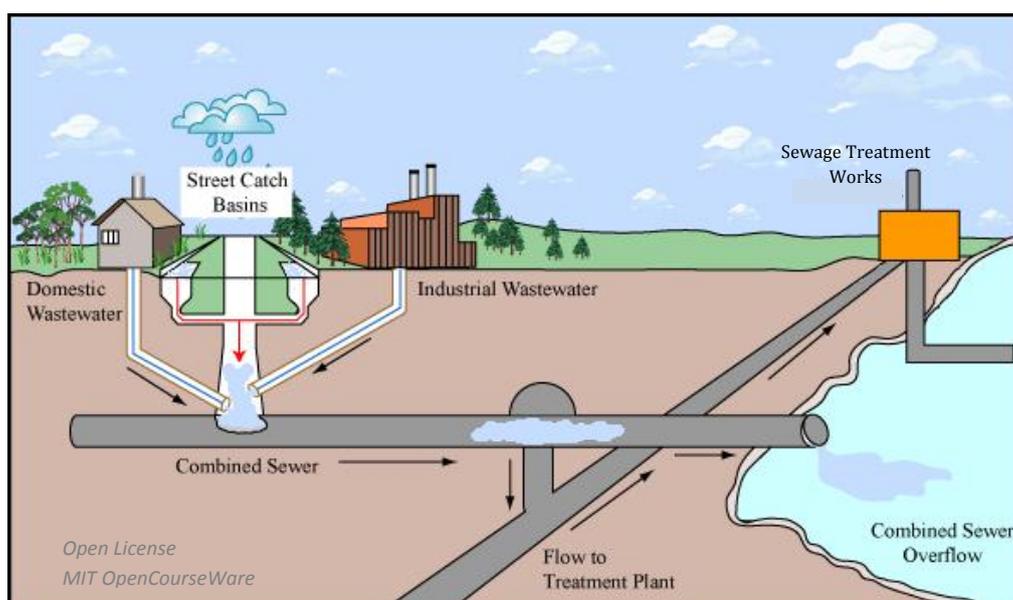
What is a Combined Sewer Overflow (CSO) and how does it work?

A combined sewer collects waste water from domestic sources, industrial sources and also street catchment basins. They are therefore vulnerable during high rain events, receiving large volumes of dilute sewage waste water which can overwhelm even the largest of storage tanks (up to 1000m³). To stop this from backing up into houses and onto the streets, a CSO acts as a release valve, releasing waste water directly into local water sources (small brooks/ watercourses). The local organisms are therefore exposed to untreated waste waters, causing the contamination of bivalve molluscs and potential human illness through consumption of these.

Regular Conditions



Storm Conditions



Characterisation

What is characterisation?

Characterisation is the understanding of how the local **tidal** and **meteorological** (weather-related) conditions, combined with the **landscape structure** (or topography), affect the **movements of contaminants** within a water body. Understanding characterisation allows **reasonable assumptions** to be made regarding the movement of a plume of sewage.

The movement of sewage plumes can determine the short term changes to shellfish water quality, which ultimately determines the classification of the water body at that time [for more information see the section 'classification'], affecting the harvesting business. The quality of bivalve mollusc growing waters is the result of mixing brought about by three primary factors: tidal currents, dilution and river inputs (Pommepeuy et al. 2005).

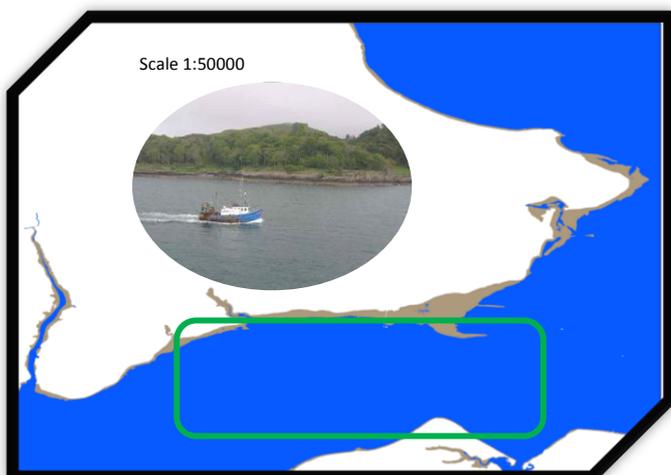
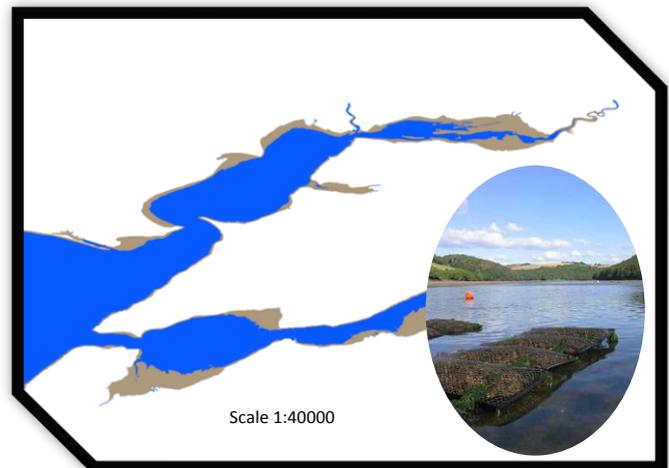
The CEFAS sanitary surveys can be found online at: <http://www.cefas.defra.gov.uk/our-science/animal-health-and-food-safety/food-safety/sanitary-surveys/england-and-wales.aspx>

What is a water body?

Within the context of this initiative, a water body is a region of coastal water classified for harvesting bivalve molluscs. These include creeks, channels, estuaries, open coastlines etc. and can be categorised as one of the following:

An enclosed water body – Often upstream of semi-enclosed water bodies, these can receive **multiple land inputs**. Being surrounded by barriers of land and fresh water inputs, these water bodies are often **narrow and shallow**, resulting in a **poor exchange** rate with oceanic waters.

From the example on the right, any bed found within the two channels would be classified as 'enclosed'.



A semi enclosed water body – An area of water which may receive **some direct inputs** from land, as well as diluted inputs from further upstream. These maintain a **good exchange** with oceanic water; therefore, any direct inputs are **quickly diluted**.

An example semi-enclosed region can be found on the left, with nearby oceanic mixing (north east).

An open water body – A major body of **oceanic water** receiving **few or no discernable inputs** from the land. Any contaminants are **diluted** by the large volume of water, and as such open water bodies can be considered to be at **lower risk** of impacting upon the harvest beds.

Exposed coastlines, such as that in the example (right), are also used for shellfish harvesting.



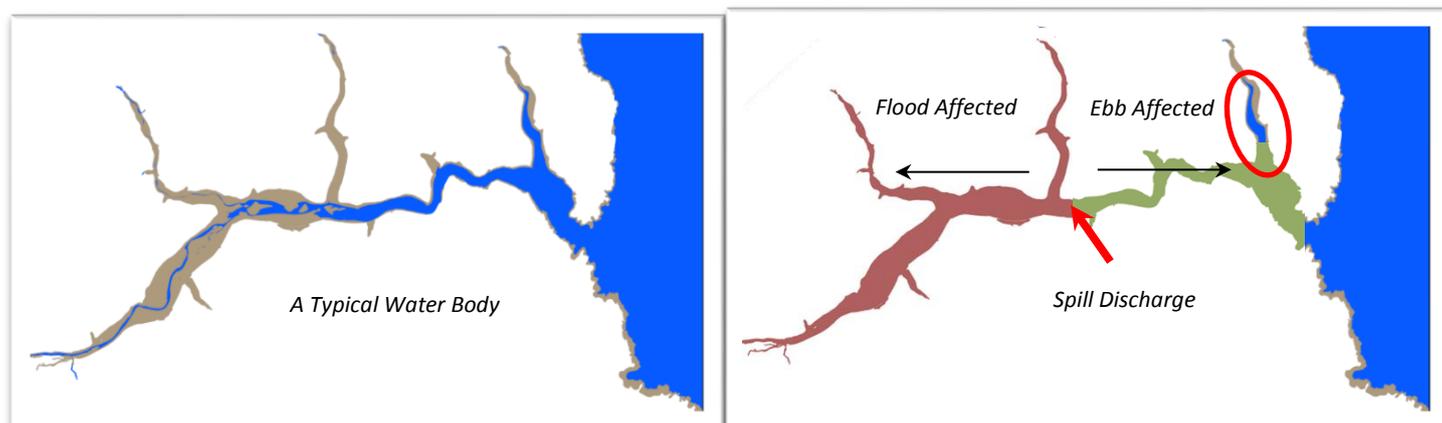
Which contaminants are of concern?

Point source waste waters, along with diffuse pollution from urban and agricultural areas, have historically been linked with the presence of *Escherichia coli* (**E. coli**), an indicator of faecal pollution. However, human viruses from sewage are also a major concern to human health. These can be accumulated and retained by bivalve molluscs. **Norovirus** is associated with human faecal contamination. The consumption of ‘ready to eat’ (uncooked) bivalve molluscs, that have been contaminated with Norovirus, can lead to short term illness. [For more information see section ‘contamination’]

Effects on water movement

Tides & Dilution

The **dominant force** that determines the movement of contaminants throughout a water body is the **tidal currents**. Depending upon the **location of harvesting**, in relation to the source of the sewage spill, contamination will be highest on **either** the **ebb** or the **flood** tide (Lart & Hudson 1993). For example:



Harvest beds located downstream of a source of pollution will be largely (but not solely) affected during an ebbing tide. The extent of contamination will depend upon the state of the tide when the spill occurs. Should a spill occur part way through an ebb tide, high tide regions of the bank (which often contain the harvest beds) may not be affected until the returning flood tide. Equally, any draining creeks downstream of the spill (as the example circled above) will only be affected on the following flood tide.

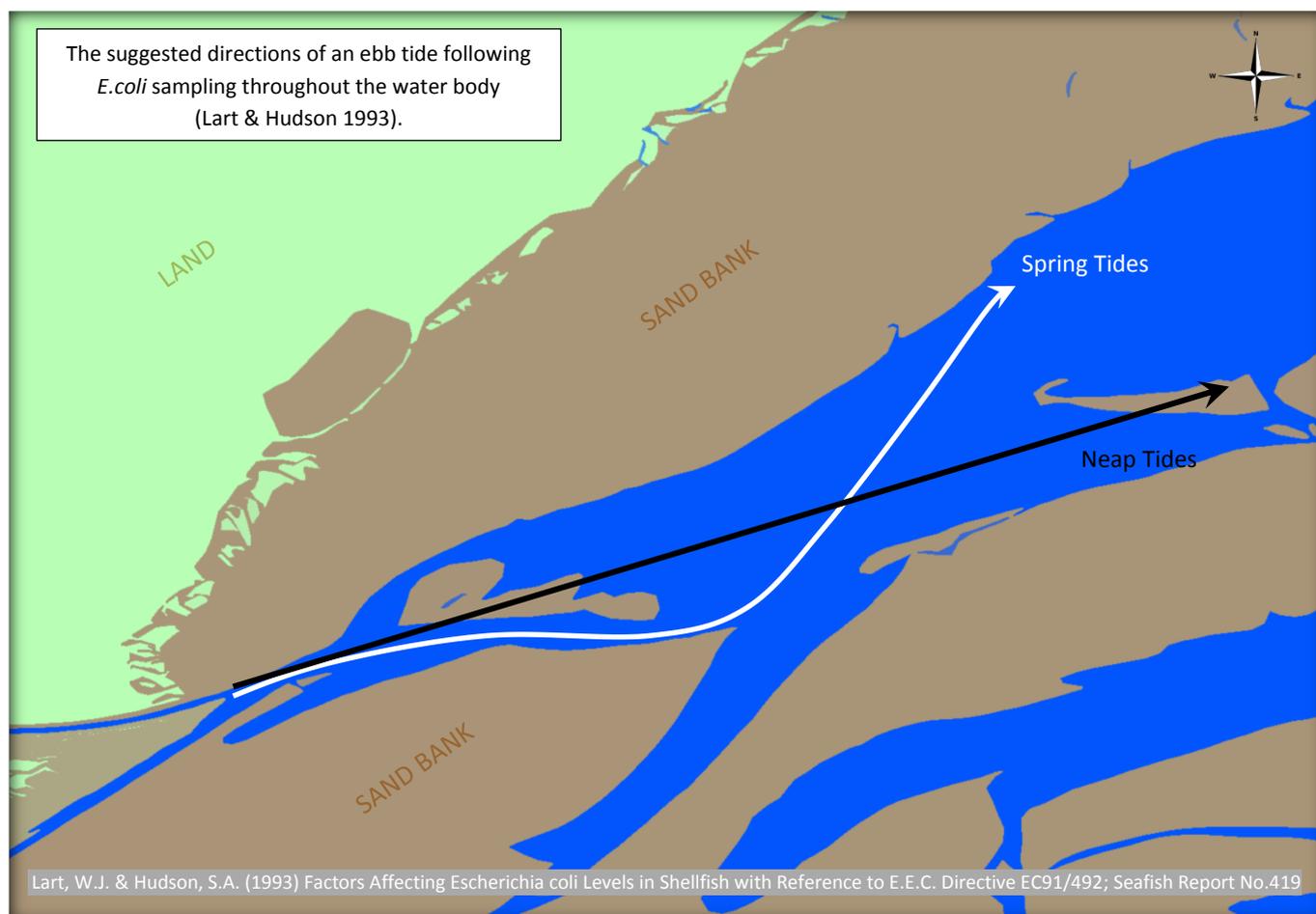
The further a bed is from the discharge source, the more time there will be for dilution and therefore the concentrations of contaminants will be reduced (Morgane et al. 2009). However, the depth of the water body will also affect dilution, with deeper waters increasing the dilution of discharge waste water.

Therefore, as the water level drops during an ebb tide, any discharges will remain at high contaminating risk to the surrounding environment. It is essential that operators upstream of a discharge point also understand these effects, as it is possible that contamination may be taken upstream on a flood tide with a minimum level of dilution.

Contaminants travelling on a flood tide are likely to affect many areas upstream of the spill. However, dilution will always have a significant influence on flood tides as water levels are constantly rising and mixing with 'cleaner' seawater. This combination of tidal forces and contaminant dilution is often the factor that determines shellfish water quality (Riou et al. 2007).

Geophysical Parameters

Sand banks and barrier islands/spits etc. can have a significant influence on the movements of currents. In turn, the state of the tide, whether **spring** (highest high tides and lowest low tides) or **neap** (lowest high tides and highest low tides), can determine the amount of influence that these structures have.



In the above example, the low water level during neap tides is high enough to allow the currents to flow **over the top** of nearby sand banks (**black arrow**). Therefore contaminants that are carried on an ebbing tide are more likely to affect **centralised** harvesting beds. However, drainage routes are dramatically altered on a spring tide, being directed **around the sand banks** (**white arrow**). This causes currents to flow **northwards** increasing the contamination risk of nearby beds.

The effects of geophysical parameters will vary in each water body, and also in response to external factors (e.g. land run-off, wind driven currents). It is therefore important that each operator knows their own environment thoroughly so that areas of risk can be accessed.

Meteorological Conditions

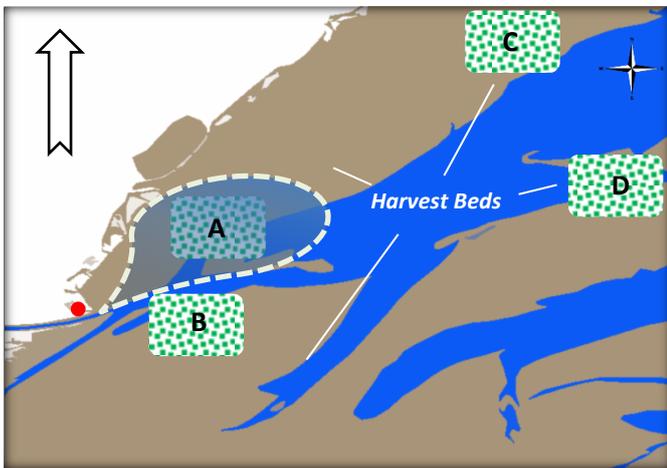
Wind

It is well documented that wind speed has an approximate **2% influence** on the current speed that it generates (Haines and Bryson 1961). Therefore, average wind speeds of 4.0-5.7m/s (in England and Wales) have a **0.08-0.12m/s** influence on the currents that are generated. Although this may appear small, the **direction of sewage plumes**, carried on tidal currents of 0.46-0.77m/s (example from the Blackwater Sanitary Survey), may still be **altered by the wind**.

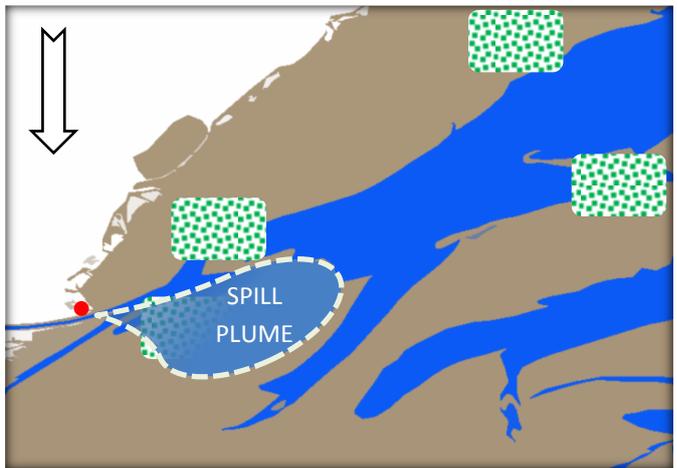
The above calculations are made on average data supplied from the Met Office and do not represent the daily variation in these conditions. It is important that any decisions that are made, given the CSO text alert information, consider the local conditions at the time of the alert.

The **direction of the wind** is also a very important factor in how the sewage plume will be affected.

North Cross-Shore Wind

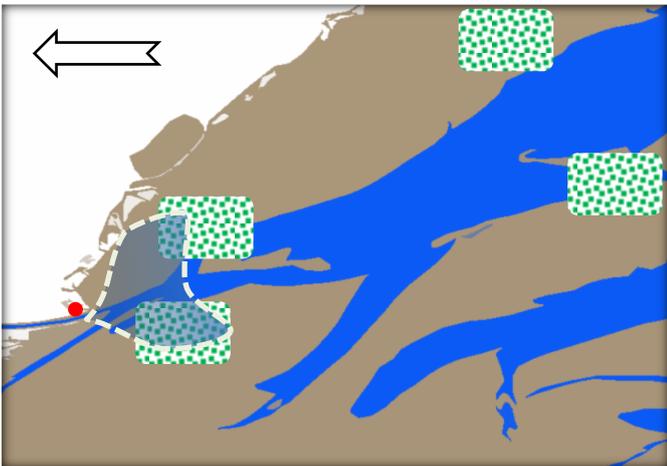


South Cross-Shore Wind

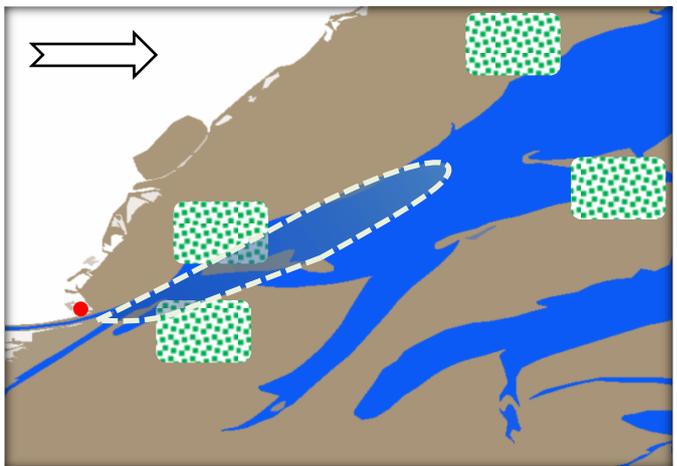


Cross-shore winds may contribute to **diverting the plume from the expected tidal movement**. In the example above, the plume is pushed slightly northwards or southwards, whilst remaining on the expected trajectory, resulting in a **more direct impact** on a single bed - bed A (north) or bed B (south), whilst the risk to the other beds is reduced at that time.

On-Shore Wind



Offshore Wind



On/Offshore winds are a little different. These can act either directly against or directly with the tidal currents.

On-shore winds could hold-up the tidal current, causing the plume to spread to the north and south and become diluted near the source. The area of impact therefore includes the two nearer beds (A and B), with the far beds only receiving a diluted sewage plume, later than usually expected. This does not guarantee that beds C and D will not be contaminated; rather it prioritises the most at risk beds.

Offshore winds could assist tidal currents, causing a reduced area of impact to the near beds. Any contamination of beds C and D would be greater than what would be expected in the other three scenarios.

Sunlight and Rainfall

The volume of rainfall that is received by a catchment area is likely to influence: a) the number of potential CSO spills, and b) the amount of impact that the water body receives from diffuse pollution sources.

Ultra Violet (U.V) irradiation, brought about by natural sunlight, may destroy/inactivate bacteria and viruses. As shellfish can become contaminated within a few hours of being exposed to contamination, increased natural light will not effectively protect beds close to discharge sources (particularly against viruses) (Riou et al. 2008).

Seasonality & Flushing Time

In a recent study, it was suggested that seasonality has no effect on the average levels of *E.coli* recorded in shellfish waters (Riou et al. 2007). However, Norovirus does have a strong seasonal correlation with the majority of outbreaks occurring during the winter months. These seasonal effects are likely to be specific to any given area. Furthermore, associated factors (e.g. increased rainfall, livestock, and tourism) are likely to be the underlying cause of any apparent seasonal fluctuation.

The flushing time of water bodies and survival rate of bacteria and viruses determine the length of time that an impact occurs. Meteorological conditions (incl. sunlight and rainfall) vary significantly between seasons. During high sunlight, low rainfall periods (spring, summer), CSO spills would be expected to occur less often than in low sunlight, high rainfall periods (autumn, winter). However, the reduced regular water inputs, during summer, also extend the duration of the flushing time. Therefore, the potential benefit of U.V. deterioration of contaminants may be equal to the reduced flushing times in winter (Riou et al 2007). The period of risk may be relatively equal throughout the seasons. It is important that harvesters recognise the duration of risk for their operating area and appreciate that this may alter with day-to-day changes in environmental conditions.

Despite CSO spills being dilute, the impact of untreated discharges has been proven to cause a 4.5x increase in the *E.coli* counts recorded on harvesting beds (Riou et al. 2008). Therefore, any area that is adjudged to be at risk from CSO spills should be effectively managed. Natural depuration rates will alter with the environmental conditions, requiring from days to weeks to become contaminant free.

These pages on characterisation highlight the importance of local knowledge and provide examples of what must be taken into account when assessing risk to the beds. Predictions of the direction, speed and impact areas of a spill can be made by the harvesters on the shore based on local conditions. Harvesters that know an area intimately are more likely to know the consequential movement of a spill. Local knowledge may be supplemented by investigations carried out by scientists, regulatory bodies and coastal management organisations (such as CEFAS, IFCA and research organisations).

Haines, D. A. & Bryson, R. A., (1961). An empirical study of windfactor in Lake Mendota; *Limnology and Oceanography*; **6 (3)**: 356–364.

Pommepeuy et al. (2005) Faecal Contamination in Coastal Areas: An Engineering Approach; In: *Oceans and Health: Pathogens in the Marine Environment*

Riou et al. (2007) Microbial impact of small tributaries on water and shellfish quality in shallow coastal areas; *Water Research*; **41 (12)**: 2774-2786.

Riou et al. (2008) The role of models in assessing the impact of sewage overflows on fecal water contamination; *Journal of Shellfish Research*

Classification

To legally harvest bivalve molluscs in the UK (as outlined in the EU Regulation No 854/2004), each harvest bed must be classified by the Food Standards Agency (FSA). Classification is determined by the quantity of *E.coli* that is present within shellfish waters, following the guidelines presented below.



Classification	Contaminant Load	Additional Information
Class A	<230 colony forming units (CFUs) <i>E.coli</i> /100g of flesh and intervalvular liquid.	Can go straight to market for direct consumption.
Class B	90% of samples must only contain 230-4,600 CFUs <i>E.coli</i> /100g of flesh and intervalvular liquid. All samples must be <46,000 CFUs	Purification in an approved depuration system; or Relayed in a class A production area. *
Class C	4,600-46,000 CFUs <i>E.coli</i> /100g of flesh and intervalvular liquid.	Relaying for an extended period (minimum of 2 months). *
Class D	>46,000 CFUs <i>E.coli</i> /100g of flesh and intervalvular liquid.	Harvesting is forbidden.

* **Shellfish can alternatively be heat treated, creating a safer food product.**

These guidelines are enforced to ensure that live bivalve molluscs meet the legal end product standards as determined by law (Regulation (EC) No 853/2004 and Regulation (EC) No 2073/2005).

Provisional classification is generally given to new harvesting beds based on 10 samples, taken at least 1 week apart. Regulatory routine sampling then commences at monthly intervals (for at least 10 months of the year). Full classification status is awarded by the FSA based on sampling results (of live bivalve mollusc flesh) measured over the previous 12 months. Long-term classification is awarded to any bed that has consistently achieved B classification for 5 years (for more information, please see the Seafish Fact Sheet on 'Classification').

Regulation (EC) No 854/2004, Annex II, Chapter II (A); Regulation (EC) No 853/2004, Annex II, Chapter II(A3); Annex III, Section VII, Chapter V (1&2);

Regulation (EC) No 2073/2005, Annex I, Chapter 1.17 & 1.24

Seafish Fact Sheet (Classification of Shellfish Harvesting Areas – Issues); Available online:

http://www.seafish.org/media/Publications/FS31Shellfishharvestingareasclassification_201001.pdf

Contamination

How are Faecal Contaminants Introduced into the Environment?

Water companies are responsible for point source sewage releases, continuously discharging treated waste waters, from sewage treatment works (STWs), into local rivers/streams. Despite pre-treatment [as described in the section 'waste water treatment'], these discharges contain a number of pathogenic microorganisms which may be accumulated by local organisms. CSOs are another licensed discharge. Although these occur less frequently than treated discharges, CSO spills receive no treatment and therefore spill high volumes of diluted waste water directly into nearby water courses [see section 'sending a CSO text alert'].

Diffuse sewage pollution is much more challenging to track and manage than point source discharges. Diffuse sources can include agricultural and live-stock run-off, urban run-off (drains and domestic appliances), sewage pipe misconnections/leakages, and seasonal tourism events (Pommepuy et al. 2005). Diffuse sewage pollution can impact water courses upstream and significantly affect the quality of shellfish harvesting waters.

The main problem with these discharges is the temporary changes to coastal water quality, which can be difficult to monitor effectively in real time.

But which contaminants are of concern?

E.coli

As the statutory indicator of faecal pollution, the presence of *E.coli* directly influences the assigned quality of the water body. *E.coli* is also an indicator of gross faecal contamination and can therefore be associated with a number of other faecal-associated pathogens (e.g. Streptococci; Norovirus) which can cause a number of illnesses from ear infections to gastroenteritis and hepatitis A.

Norovirus

Incidents of gastroenteritis, associated with the consumption of bivalve molluscs, are more commonly reported than potentially more dangerous illnesses associated with faecal contamination (e.g. hepatitis A). Norovirus, often associated with gastroenteritis, is highly contagious between human beings, with symptoms, including diarrhoea and vomiting, usually abating within 48 hours. There are a number of routes of Norovirus transmission including: person-to-person, which is believed to be the largest cause of the spread of infection; and food-borne (leafy vegetables, soft fruit and shellfish). Cross contamination by asymptomatic food handlers is also thought to be a significant route of infection, highlighting the importance of ensuring strict cleanliness and hygienic practices in such workplaces. Outbreaks of noroviral gastroenteritis are seasonal, peaking during the winter months. This may be due to reduced sunlight (reduced natural viral breakdown), slower metabolism in colder weather (extending the time needed to naturally purify), and increased rainfall with corresponding CSO spills (Pommepuy et al. 2005).

Current operations for reducing the *E.coli* concentrations within bivalve molluscs (depuration and relaying) have not been proven to effectively reduce the concentrations of Norovirus. Furthermore, there is not a clear relationship between the concentrations of *E.coli* and Norovirus. Therefore, classification of water bodies that does not take viruses (in particular Norovirus) into account may underestimate the risk to consumers (for more information please see the Seafish factsheet on 'Norovirus' below).

Pommepuy et al. (2005) Faecal Contamination in Coastal Areas: An Engineering Approach; *Oceans and Health: Pathogens in the Marine Environment*

Seafish Fact Sheet (Norovirus); available online: http://www.seafish.org/media/Publications/FactsheetNorovirusinlivebivalvemolluscs_201009.pdf

Waste Water Treatment:

Primary, Secondary and Tertiary Treatment

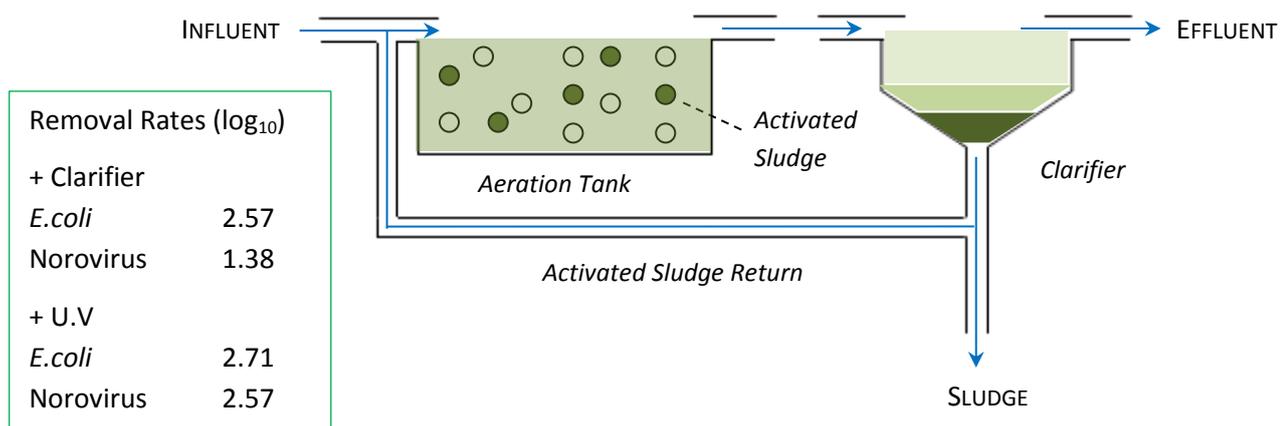
As waste waters are collected from domestic, industrial and catchment sources, they are preliminarily **screened** using a **simple grid** to remove large debris that might otherwise damage pipelines and cause blockages. Excess **grits, oils and greases** are also removed to create more manageable waste water.

Any solids are then removed during **settlement** processes which form the **primary treatment** of the waste water. This can be improved through the addition of **chemical flocculants**, removing the fine contaminants.

Primary Treatment

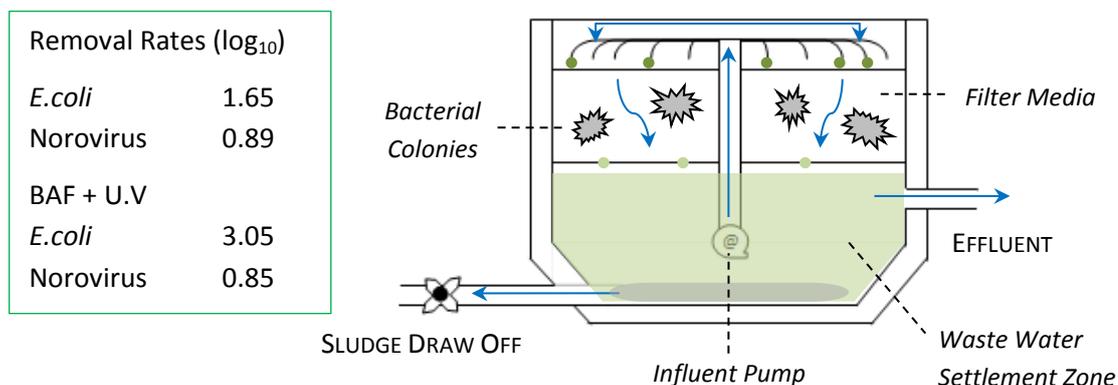
Activated Sludge Treatment (AST)

This **two stage process** combines **primary and secondary** treatment. The waste water is **aerated**, starting a biological reaction, and the solids and liquids are **separated** through gravity sedimentation. As the tanks are interconnected, the **activated sludge** (includes various **micro-organisms**) gathered in the clarifier can be recycled into the aeration tank. This process **removes organic material** from the waste water.



Biological Filter (BF)

Biological filters can act as **primary or secondary** treatment options. Waste water is drizzled onto a plastic filter where natural ventilation gives enough **oxygen** to allow **bacterial growth**. The **biochemical oxygen demand (B.O.D) is reduced** and treated waste water is allowed to settle removing any solids that have sheared away during the process.

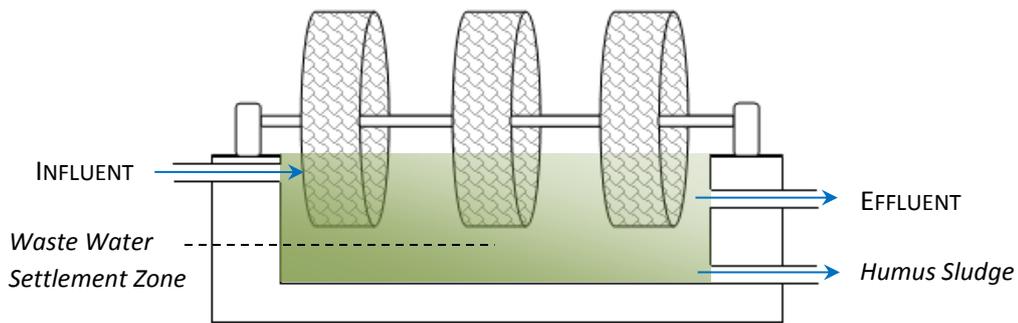


Secondary Treatment

The following three methods provide **secondary** treatment of waste water, each using **bacterial growth** to **remove the organic pollutants** in the waste.

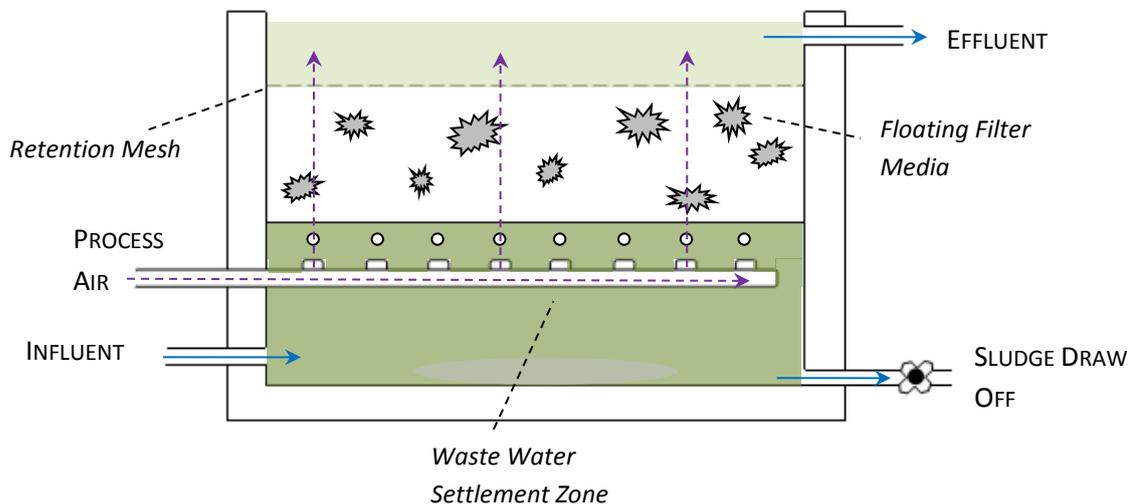
Rotating Biological Contactor (RBC)

Plastic discs, which act as a bacterial platform, are rotated into a tank of settling waste water, **alternating exposure** to oxygen. Organic pollutants are absorbed by the biomass and are then **oxidized** during the aerial phase.



Biological Aerated Filter (BAF)

The diffuser lies below the floating bacterial medium, generating bubbles and **oxygenating** the system. The filter is blocked from time to time with trapped solids and growing biomass, being cleared by **backwashing with treated effluent**. The waste sludge then settles and is drawn off.



All information and images presented in this document have been adapted from:

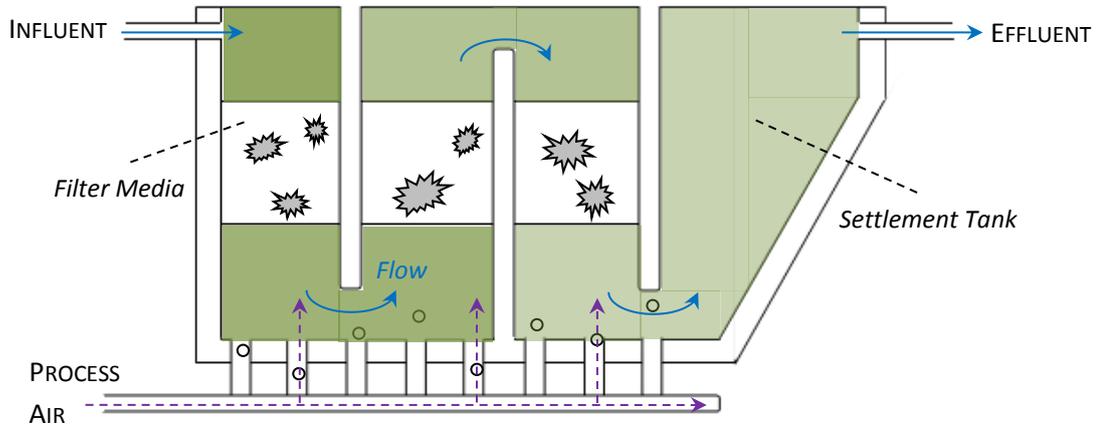
<http://www.watermaxim.co.uk/sewage-systems.php> Copyright © 2007 Water Maxim

All removal rates acquired from:

Palfrey et al. (2011) Impact of Waste Water Treatment on Removal of Noroviruses from Sewage; *WRc R&D Technical Report WT0924/TR* (Please note that this was a very small study. The results should therefore be used as a general comparison of treatment efficiency)

Submerged Aerated Filter (SAF)

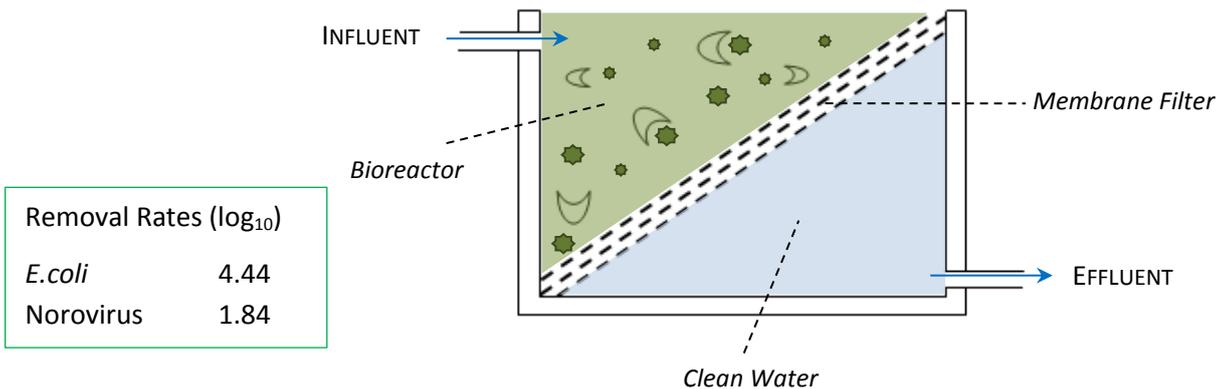
In a similar manner to the biological aerated filter, oxygen is pumped into the system below the filter medium. This promotes efficient mixing and removal of blockages, without the need for backwashing.



Tertiary Treatment

Membrane Bioreactor (MBR)

Membrane bioreactors (MBRs) are used widely for the **tertiary** treatment of domestic and industrial waste waters. A **high quality effluent** is produced which can be discharged into local water courses. This treatment further reduces the chemical and biochemical oxygen demand (**C.O.D and B.O.D**) of the waste water, **reducing the potential environmental impact**. MBRs are also improved by **the removal of nitrogen and phosphate**, minimising eutrophication in receiving waters.

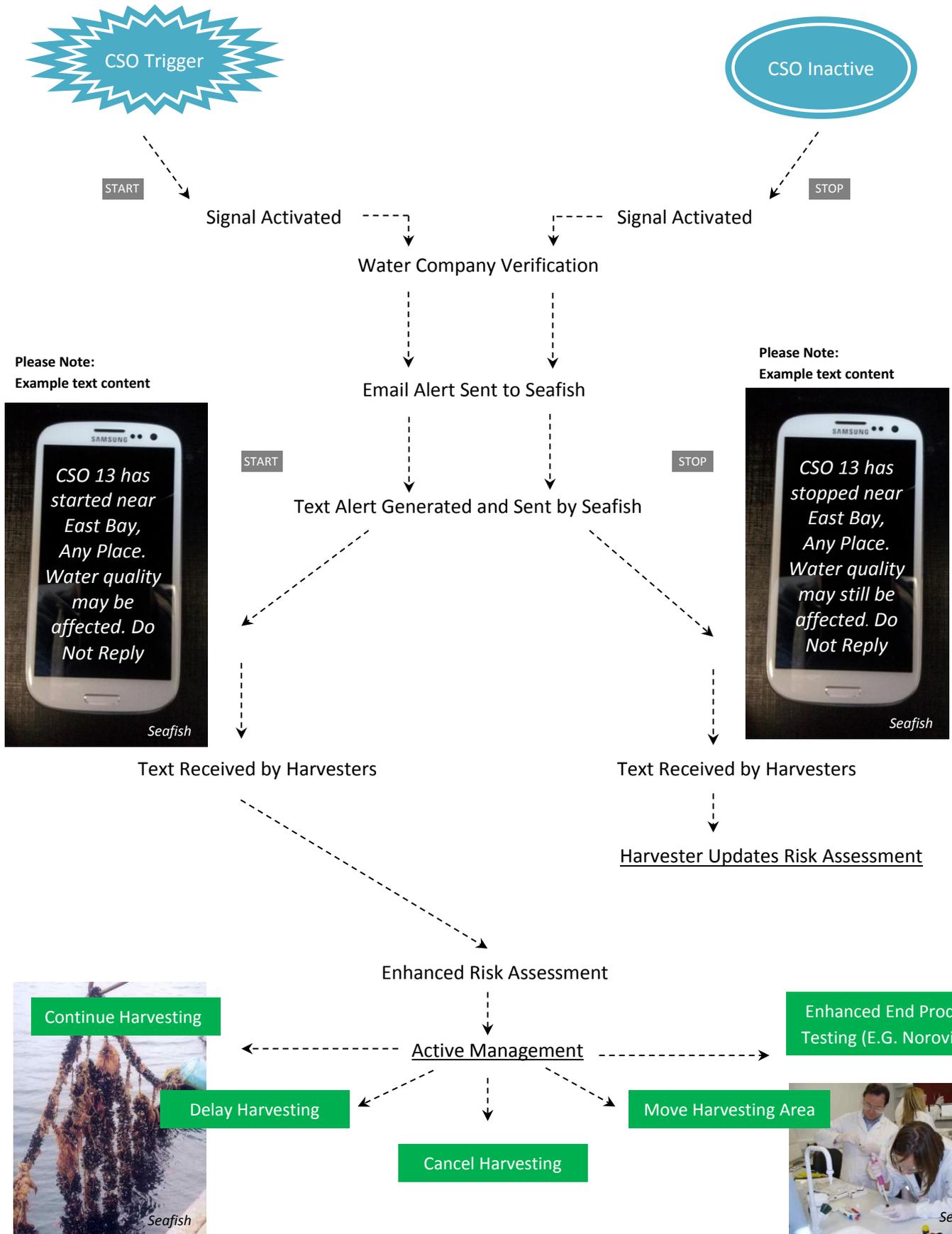


Under the Urban Waste Water Treatment Directive (91/271/EEC) [Overview: http://ec.europa.eu/environment/water/water-urbanwaste/index_en.html], discharges to ‘sensitive’ areas (including shellfish waters) must receive tertiary treatment, which often includes **U.V** treatment and occasionally reed beds. These processes are usually a final step in the treatment process, producing a high quality discharge that should have little impact on the receiving environment. The cost of this additional treatment is built into consumer bills, as it is of direct benefit to local environmental quality and, with regards to shellfish production, consumer health.

Sending a CSO Text Alert

Storm Event

CSO Spill Stopped



Attributes and Benefits of the Text Alerts

Active Management

The information in the text alerts is intended to provide operating harvesters with a quick response warning to CSO spill events. The information itself provides no direct advice on how to proceed with operations, but rather give a time window in which beds may be at greater risk of faecal contamination. Furthermore, by providing the entry point for each spill alert, harvesters can assess local tidal, geophysical and meteorological conditions [as outlined in the section 'characterisation'], and determine the likely direction of a plume of sewage effluent. This process of enhanced risk assessment will form the basis for active management decisions.

Operating Decisions

- Continue Harvesting

If the harvester judges that there is a very low risk of contamination to their shellfish beds, then they may wish to continue operations as planned. Alternatively, harvesters may wish to invest in enhanced end product testing to ensure that the product is suitable for market during this period of increased risk.

- Delay Harvesting

Operations may be postponed for a period of time that the harvester has judged to be sufficient to reduce the risk of contamination. Some water companies will provide an email alert following a spill (once a CSO has not triggered for 24 hours), producing a 'stop' text message. Any decision upon the length of time required for natural purification should be made after this text is received by the harvester.

- Cancel Harvesting

If the risk is judged to be too great, any pending harvesting operations may be cancelled until further notice. This may be due to a series of storm events that trigger multiple spills and cause wide-scale contamination.

- Move Harvesting Areas

Should a harvester operate on a number of beds, they may wish to switch their harvesting intentions from a bed they have judged to be high risk to a lower risk bed.

- Enhanced End Product Testing

With Norovirus being of particular concern during discharges of faecal waste waters, harvesters may wish to invest in enhanced Norovirus testing. Any testing of the bivalve's health during these high risk periods will only assist in understanding the impacts of CSO spills and thus inform the active management that is consequently required.

-Health Warning-

The provision of information on CSO spills IS NOT a substitute for appropriate risk assessment and/or adequate microbial and viral sampling.

Seafish, UK water companies and SAGB cannot be held responsible for any decisions made by the harvesters in response to the CSO text alerts.

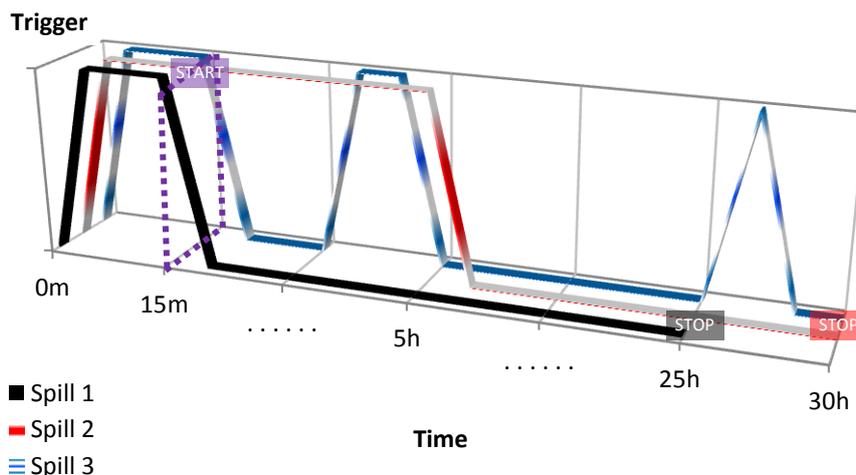
Profile of a Spill

-Scenario One-

This scenario dictates that a start alert will only be sent after 15 minutes of a continuous discharge.

Furthermore, a stop alert will only be sent once a trigger has not been received for 24 hours.

Therefore, there are three possible spills that we must consider (right).



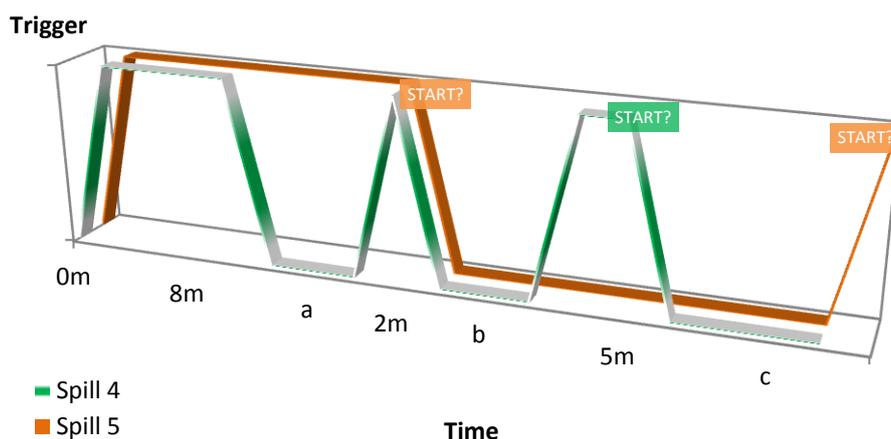
Text alert sent for all three spills. As spill 1 ends immediately after 15 mins, a stop alert will be sent at ~ 25h. Spill 2 continues for a further 5 hours, so the stop alert will be delayed until ~ 30h. Spill 3 re-spikes after a 20 hour stop, therefore, a further 24 hours without a trigger is required before a stop alert can be sent.

-Scenario Two-

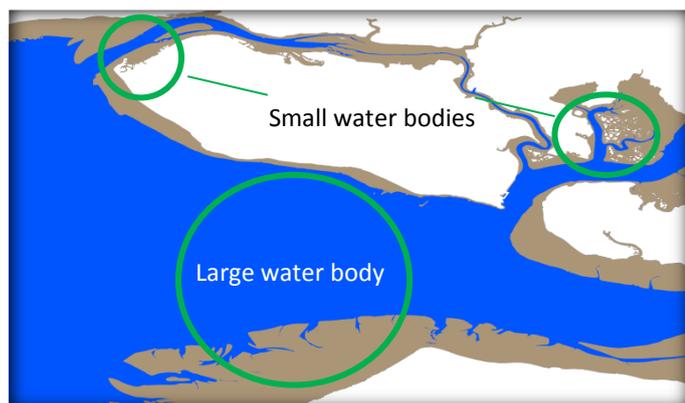
Should multiple spills occur, of <15 minutes duration, an accumulation system has been recommended.

For spill 4, the combined time of a+b determines whether an alert is sent where indicated.

During spill 5, if $a \geq 5$ mins the spill will exceed 15mins in duration triggering a scenario one alert. However, if $a < 5$ mins, the time incorporating $b+5m+c$ will determine whether an alert is sent once a second spill occurs.



The size of the receiving water will significantly impact the maximum duration of risk throughout an accumulation event. A larger receiving body of water has a greater rate of dilution when there is a spill. Therefore, an accumulation event would have to occur within a short space of time (e.g. 1 hour) to cause an impact. In a smaller body of water (channel, creek, fleet, stream or enclosed bay) the risk is much greater as the dilution is reduced. Significant accumulation can occur over a greater time period (e.g. 12 hours). When a CSO spill may impact both small and large receiving waters, the criteria for an alert must follow that of a small water body, unless agreed otherwise.



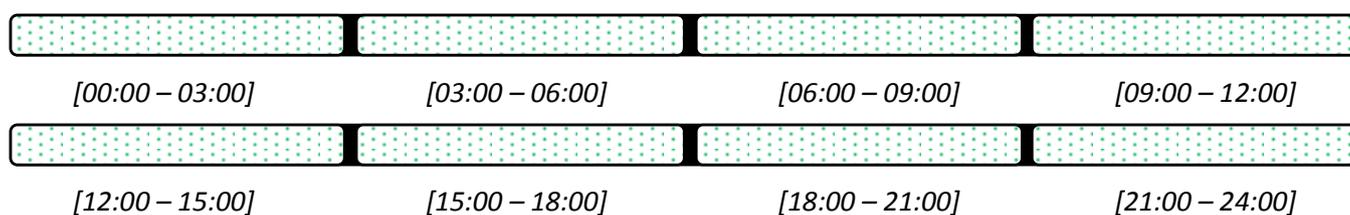
The duration of the accumulation trigger will vary dependent upon the agreement with water companies.

Spill Accumulation

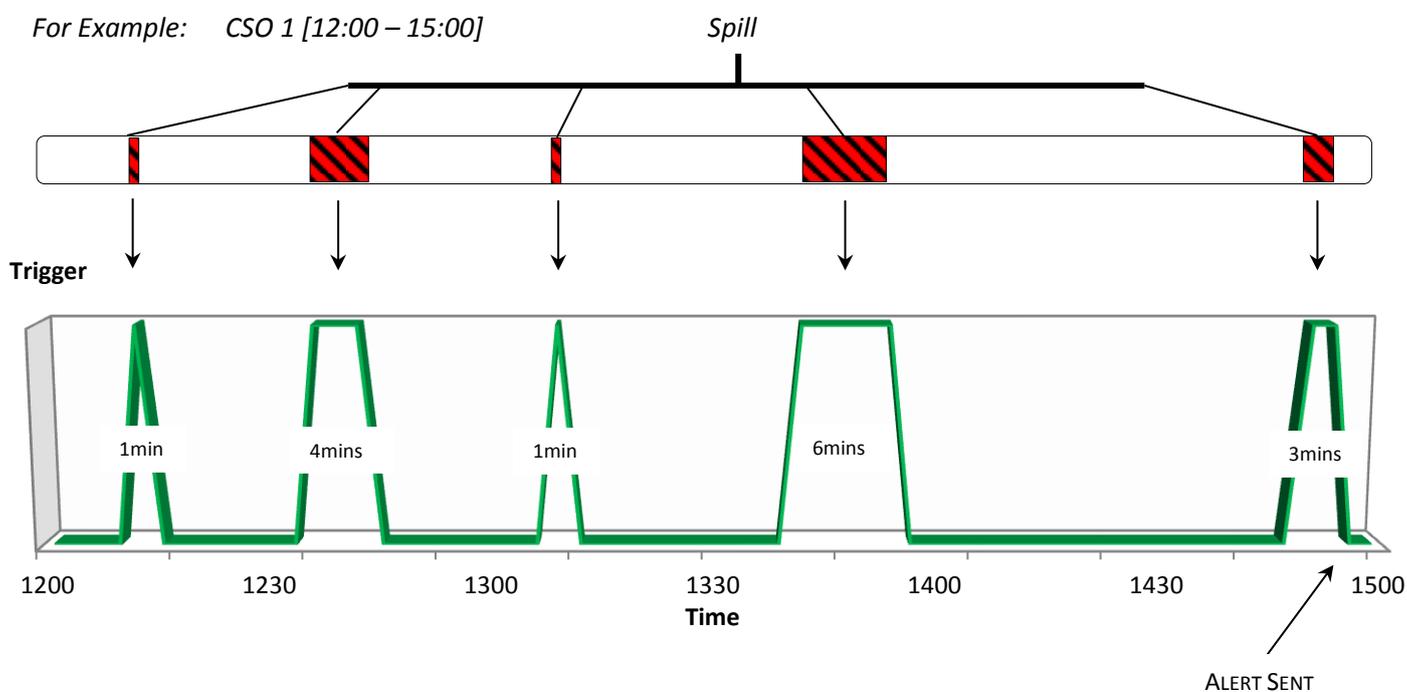
From any one CSO, spills that last for less than the specified trigger period (e.g. 15 minutes) will not trigger a CSO text alert on their own. This precaution is taken so that false alerts are not generated due to small, uncontrollable spikes in the telemetry data.

It is important that small spills are not completely ignored, as these may add together (accumulate) and may have a significant environmental impact. The likelihood of these spills having an impact will depend upon the timescale over which a number of small spills occur.

The current ability of the illustrated accumulation system is to monitor set three hour periods, for each CSO, throughout the day. All spills are recorded in the following manner:



In any one of these periods, the combined time of all spills will be recorded. If this exceeds 15 minutes, at any point, then a text alert will be sent to registered recipients in that region.



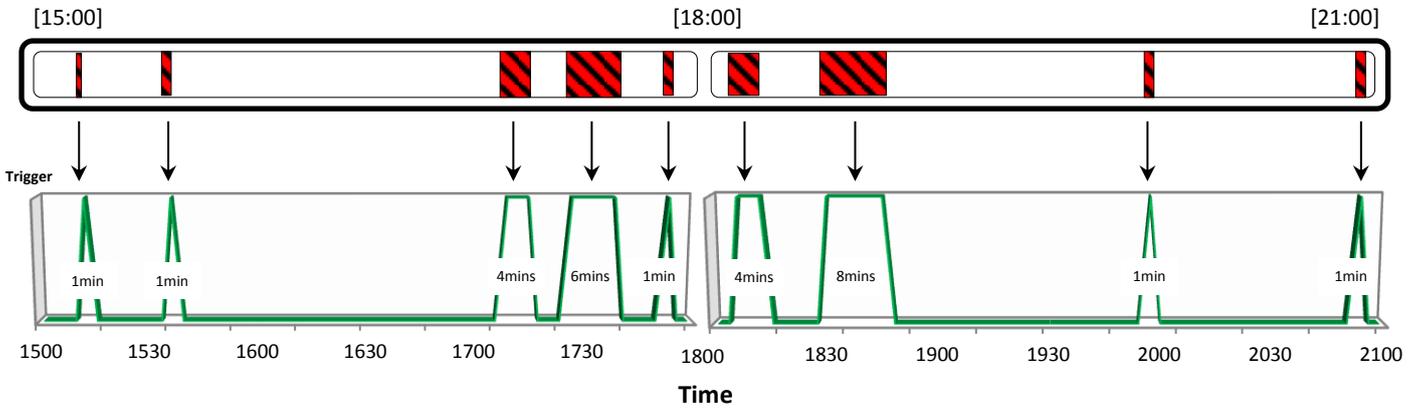
Within the [12:00 – 15:00] time window, a total of 15 minutes of CSO spills were recorded from CSO 1. A text alert would be generated at 14:55 to alert all harvesting beds that may be affected.

SYSTEM LIMITATION

Spill accumulation will be reset at the beginning of each three hour period. Therefore, it is possible that more than 15 minutes of spill may occur within three hours without triggering an alert.

An example would be:

CSO 5 [15:00 – 21:00]



Each three hour accumulates less than 15 minutes of spill (with 13 minutes from 15:00-18:00 & 14 minutes from 18:00-21:00), yet as you can see, there is a significant period of spills between 17:00 and 19:00. During this two hour period, a total of 23 minutes of spills are recorded. As this overlaps the three hour boundary, the system is reset after 13 minutes of spills and does not send an alert in response.

Fortunately, these events are unlikely to occur often without triggering an accumulation event within one of the two time windows.

The above scenario is not representative of all potential profiles of notification. The profile used will be a reflection of the monitoring system used by the water company and the ability of the Seafish system to synchronise with it.

How to Register

To receive text alerts informing you of a CSO spill in your local area, when activated, simply follow the registration link on the Seafish website. ----- <http://www.seafish.org/aquaculture> -----

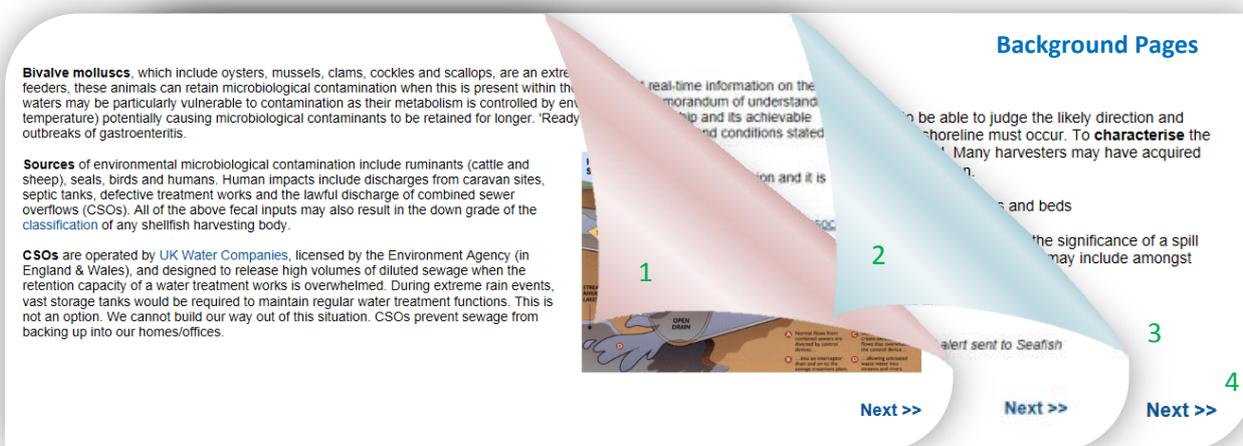
You will need to:

- 1) Complete a small section of personal details
- 2) Select your main harvesting bed
- 3) Agree to the terms and conditions of use

-Health Warning-
The provision of information on CSO spills IS NOT a substitute for appropriate risk assessment and/or adequate microbial and viral sampling.

Step 1 - Background

When you access the registration web page, the background pages will appear. These will give you an overview of the CSO alert project and back up the information given in the good manufacturing practice guidelines on coastal characterisation.



There are four background pages in total before registration begins. You will then have the option to begin as a new user or to sign into your account if you are an existing user.

You will need your email and password provided during registration to log into your account. These will be emailed to you, for your information, once registration has been completed.

The image shows a screenshot of the 'Step 2 - Personal Details' registration form. The form is titled 'Personal Details' and contains several input fields and checkboxes. The fields include: First name, Surname, Company name, Email, Mobile, Password, Confirm password, Address, County, Postcode, Country (dropdown menu), Registered Buyers & Sellers I.D Number, Company, Position, Reason for applying, and a checkbox for 'Please tick if you are a non harvesting stakeholder, and fill out the fields below.' There are also radio buttons for 'Are you a member of the SAGB?' with 'yes' and 'no' options. The form has '<< Previous' and 'Next >>' buttons at the bottom.

Enter your details in the required boxes, and indicate if you are an SAGB member and/or an MMO registered buyer and/or seller of seafood. If you are not MMO registered, please leave this box blank, tick where appropriate and complete the three boxes below.

Step 3 – Selecting Your Bed

- * Region
- East (Eng)
 - North East (Eng)
 - North West (Eng)
 - Northern Ireland
 - Scotland
 - South West (Eng)
 - South/South East (Eng)
 - Wales
 - Wessex (Eng)

Not sure which region? Please check this map.

* Production area

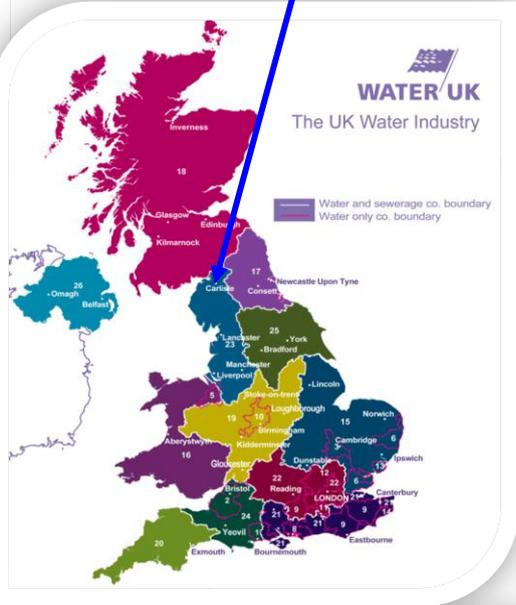
- Lune
- Morecambe Bay - Barrow
- Morecambe Bay - East
- Morecambe Bay - Roosebeck
- Ribble
- Silloth

* Bed name

- North Wharf
- Kings Scar
- Perch Scar
- Wyre End Scar
- Sea Centre
- Knott Spit
- Marine Beach
- Pilling Sands
- Cockerham Sands
- Plover Scar

Where Do You Operate?

Next >>



It is important that you only select the correct bed(s), in the production area(s) you harvest in, to ensure that you receive only relevant alerts. If you are unsure which region and/or bed applies to you, maps are provided to assist. Then simply:

1. Select your region
2. Select your production area
3. Select your bed

Step 4 – Terms and Conditions

Terms and Conditions

1. Maintenance – Monitoring equipment used to obtain performance information from combined sewer overflows is likely to be affected by adverse weather, mechanical or electrical failure and periodic maintenance.

2. Information Transfer – Processes by which notifications (hereby known as "Information") are generated and communicated may, at any time, be subject to change without prior notification.

3. The Service & Liability

3.1 All information generated will be based on raw data and therefore not audited. The information is generated by UK water companies and communicated to Seafish. Seafish will use reasonable endeavours to communicate the information to users who have registered to receive mobile text alerts on combined sewer overflow spills (hereby known as "Users"). System functionality may vary and/or be lost at short or no notice. Seafish cannot be held responsible for the failure to notify users of a spill due to system maintenance and/or loss of capability in whatever form.

3.2 Any and all received information, reports, commentary or other material, communicated to any User is not intended to amount to advice on which reliance should be placed. Such information is provided without any guarantees, conditions or warranties as to its accuracy, and Seafish and all UK water companies disclaim all liability and responsibility arising from (i) any reliance placed on the information provided and (ii) any failure on the part of either Seafish or the relevant UK water company to communicate information to a User.

4. Conditions, Warranties and Terms – To the extent permitted by law, Seafish and all UK water companies expressly exclude all conditions, warranties and terms implied by statute, common law or law of equity and any and all liability for direct, indirect or consequential loss or damage incurred by any User in relation to information use or unavailability. This includes, without limitation, any liability for loss of: income or revenue, business, profits or contracts, anticipated savings, data, goodwill, any time wasted (office or management) and for any other loss or damage resulting from or caused by tort (including negligence), breach of contract or otherwise (even if foreseeable).

5. Intellectual Property – The systems developed, including future development thereof, by which the information is collected, analysed and transmitted remains the sole intellectual property of the relevant UK water company and the User shall not be permitted to re-use or otherwise communicate the information to any third party without the prior written consent of the relevant UK Water Company and Seafish.

6. Governing Law – These terms and conditions shall be governed by and construed in accordance with English law and the parties hereby submit to the exclusive jurisdiction of the English courts.

7. Information Use – The provision of information on CSO spills **IS NOT** a substitute for appropriate risk assessment and/or adequate microbial and viral sampling.

Tick here to confirm that you have read, fully understand And accept the terms and conditions stated above.

<< Previous

Next >>

Thoroughly read the terms and conditions of use. It is important that these are understood. Please tick to accept the terms and conditions and continue with your registration.

Click 'Next' and this concludes the registration process. Confirmation details should appear on screen and also be sent to the registered email address. Should a different screen appear please refer to step 5

Step 5 - Please Note

SAGB Membership

Caution: Read Carefully

For the region that you have nominated, membership of the SAGB is a prerequisite of registration. Therefore you cannot receive mobile updates unless you first registered to become a member of SAGB.

To fulfil this criteria click the link as directed.

[Become an SAGB Member Today](#)

Your registration details have been saved. Should you wish to continue your registration after obtaining SAGB membership please log into your account by following the link on the registration home page.

[<< Previous](#)

[Next >>](#)

Membership of the SAGB is a prerequisite of registration. Therefore mobile updates cannot be received unless you first registered to become a member of SAGB. For this situation, a page will appear after the terms and conditions with a link to the SAGB website.

Step 6 – Returning Users

Spill Alert System - Your Account

Welcome Seafish | [sign out](#)

Manage your account

[Personal details](#)
[Alert subscriptions](#)
[Change password](#)
[Deregister from this service](#)

Manage alert subscriptions

Region	Production area	Bed	Status	X
East	Brancaster	Thornham	Active	unsubscribe
East	The Wash - Kings Lynn	Hunstanton	Active	unsubscribe
East	The Wash - Kings Lynn	Heacham	Active	unsubscribe

[Subscribe to another bed](#)

[<< Previous](#)

Subscribe to another bed

Welcome Seafish | [sign out](#)

* Region East
 North East
 North West
 Northern Ireland
 Scotland
 South West
 South/South East
 Wales
 Wessex

* Production area

* Bed name

[<< Previous](#)

[Subscribe >>](#)

Once registered, you can add or remove harvesting beds should you need. Simply:

1. log into your account
2. click 'Alert subscriptions' – this will show you your currently registered beds
3. click 'unsubscribe' next to the bed you wish to remove; or click 'Subscribe to another bed' – this will direct you to an identical page to 'where do you operate' [step 3]
4. chose an additional bed and click 'Subscribe'
5. repeat this process until you are happy with your account

Please be aware that only 'active' beds will receive text alerts. You will only be accepted to receive alerts on beds within your region of operation.

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Regulation (EC) No 2073/2005;
Urban Waste Water Treatment Directive (91/271/EEC); Available Online: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1991:135:0040:0052:EN:PDF>

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